Bulletin No. 93 January, 1942

Raspberry Diseases In Maryland

Description and Control

WALTER F. JEFFERS
MARK W. WOODS

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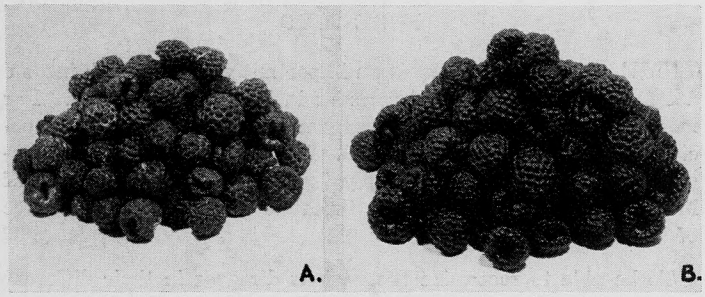

A—100 berries from plants affected with mild streak.
B—100 berries from healthy plants.

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FOREWORD

THE raspberry industry is an important source of cash income for a large number of farmers in Western Maryland. For many years raspberries were grown in that area without special attention to disease control. During the last decade, diseases have increased so sharply in the raspberry plantings of Maryland that they seriously threaten this substantial source of income.

To be able to recognize the various diseases in their different stages of development, and to be informed as to the most effective means and methods for control are essential to maintain the plantings in productive, profitable condition.

It is the purpose of this bulletin to present descriptions of raspberry diseases and facts concerning their control in such form as to enable growers to prevent much of the loss they are suffering annually. I am confident that a careful study of the information contained in it, and frequent reference to it, will be of great value to growers of raspberries.

T. B. SYMONS,
Director.

Co-operative Extension Work in Agriculture and Home Economics,
Extension Service, University of Maryland, and United
States Department of Agriculture, Co-operating.
T. B. SYMONS, Director

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Raspberry Diseases In Maryland

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WALTER F. JEFFERS and MARK W. WOODS, *Botany Department*

FREEDOM from disease, especially at the end of the first year of growth, is most important among the many factors affecting the total profitable life of a raspberry planting. Unless the virus, or "running out" diseases have been mostly eliminated in the first growing season, the planting will lose vigor rapidly in succeeding years. *Most raspberry diseases can be carried in the planting stock* and in this way many growers unwittingly introduce disease into their new plantings at the beginning. Also, many of the disease-producing parasites or agents can be carried by wind or insects for considerable distances and may be spread from patch to patch. *Thus, to a considerable extent, raspberry disease control is a community problem.*

This bulletin describes important raspberry diseases and gives information for their control under Maryland conditions. If raspberries are to be maintained as an important source of cash income to a large number of Maryland growers an efficient disease control program must be followed.

VIRUS OR RUNNING OUT DISEASES[1]

(Cannot be controlled by spraying or pruning)

Mosaic Diseases

There are two kinds of mosaic which have certain properties in common. Control measures are the same for both.

GREEN MOSAIC

Green mosaic is caused by a virus that can attack both red and black raspberries. Black caps are usually injured more

[1]For summarized control procedures, covering all the raspberry diseases, see section entitled *"General Control Practices."*

than the reds. As this disease is easily spread from one variety to another the red raspberries constitute a severe menace to black caps when the two are planted close to each other. The causal virus is carried by two kinds of plant lice (aphids). A single infected louse can infect one or more healthy plants.

Symptoms: Green mosaic may be hard to recognize on the red raspberry and different varieties give different reactions. Usually the leaves of red raspberries are mottled with patches of lighter and darker green than normal. In some varieties, the whole plant is much stunted and the quantity and quality of the fruit greatly reduced. Other varieties, like Latham or Newburgh, may show only mild symptoms. On the whole, infected plants are less vigorous and more subject to other diseases. Figure 1 illustrates symptoms of green mosaic in red raspberry.

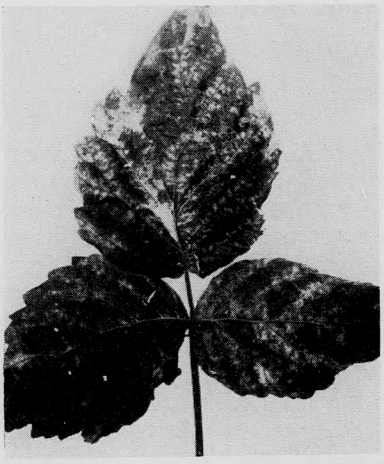

FIG. 1. *Symptoms of green mosaic in red raspberry.*

Black raspberries respond in various ways to infection with green mosaic. If new canes are infected early in their growth, the stem tips may die and curl over. Later such plants produce mottled or distorted leaves. Leaves of laterals from the new cane or from the fruiting cane may show an irregular mottling with light and dark green patches (Figure 2A). There is a general reduction in size and vigor of the plant and the berries are small and "seedy".

In infected new canes the stem tip tapers more than usual and is noticeably brittle. There is often a yellowish cast to the tip leaves and in extreme cases the terminal leaves are packed together to form a rosette (Figure 2B). Mottling of the leaves may occur later in the season, or in the second year following infection. Infected plants die in one or two seasons or persist in a weakened condition. With some forms of green mosaic, plants may be quite vigorous on good soil and make salable crops. Infected canes, however, never produce a crop equal to that of healthy plants. A plant in late stages of infection is shown in Figure 2C.

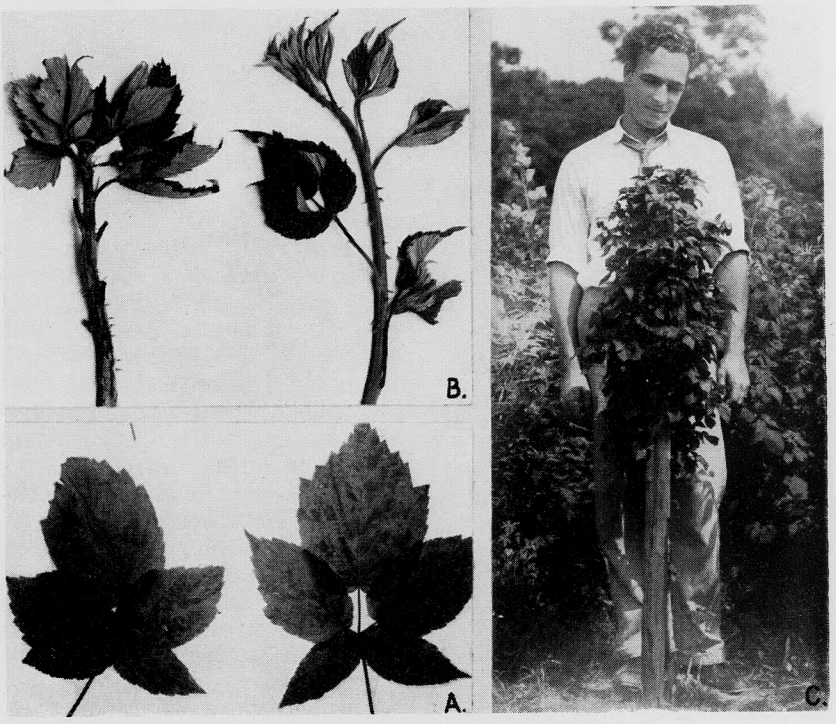

FIG. 2. *A—Symptoms of green mosaic in leaves of black raspberry.*

B—Stunting of tip of black raspberry plant due to green mosaic; there are the same number of leaves on the stunted tip at left as there are on the healthy tip at right.

C—Stunting of entire plant of black raspberry due to green mosaic.

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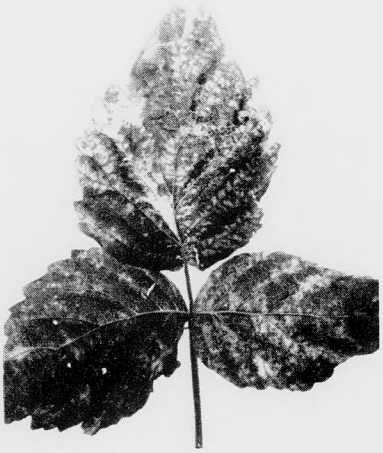

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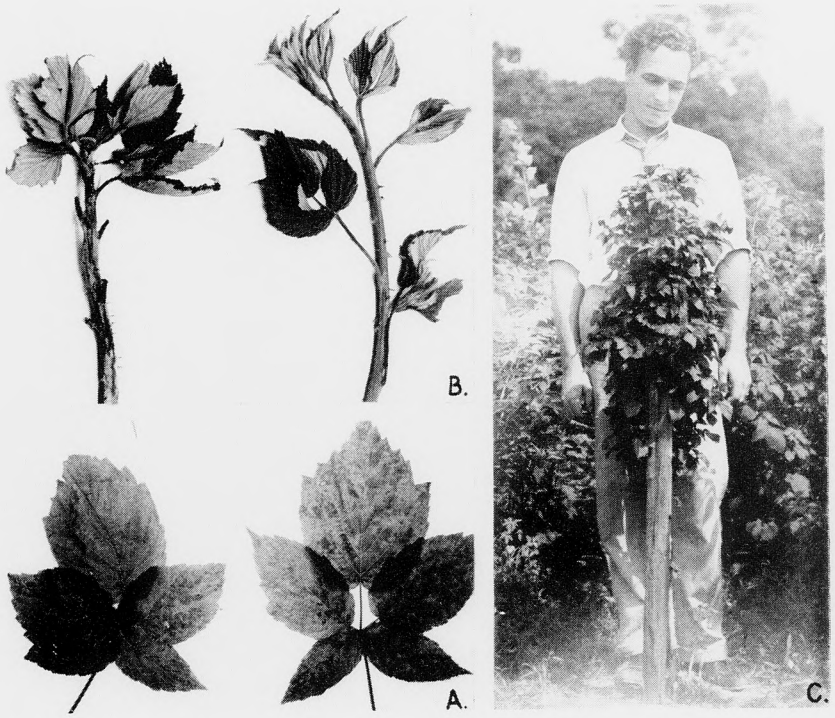

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B—Stunting of tip of black raspberry plant due to green mosaic; there are the same number of leaves on the stunted tip at left as there are on the healthy tip at right.

C—Stunting of entire plant of black raspberry due to green mosaic.

In either red or black raspberries the symptoms of green mosaic may disappear in hot weather. This high temperature "masking" of the symptoms is very misleading (Figure 3). The plants are not "growing out" or overcoming the condition, for in the next season they will be fully as diseased as they were in the first spring.

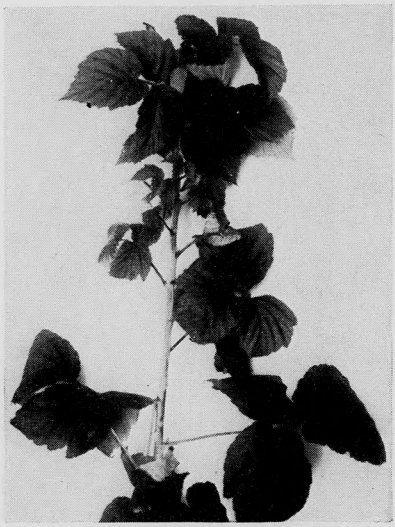

FIG. 3 *Masking of green mosaic by high temperature. The center small leaves were affected by green mosaic in a cool period, but as the weather became warmer the newer leaves at the tip were not affected.*

YELLOW MOSAIC

Yellow mosaic also attacks both red and black raspberries but is usually less common on the black caps than is green mosaic.

Symptoms: Typical yellow mosaic symptoms consist of a general yellowing of the leaves. This yellowing is not the same as that seen in leaves that are dying but is a brighter and more distinct coloration. Usually the yellow color extends over the whole leaf, or large areas of the leaflets, and does not occur in patch-like spots as does green mosaic. There is often considerable leaf deformity associated with yellow mosaic. This is usually noticeable as a cupping and narrowing of the leaflets. Figure 4 illustrates symptoms of yellow mosaic on red raspberry.

The virus causing this disease is also carried by plant lice but generally spreads more slowly than green mosaic. It differs further from green mosaic in that high temperatures do not cause the symptoms to disappear.

MIXED INFECTIONS OF MOSAIC

A red or black raspberry plant may be infected at the same time with both green and yellow mosaics. A variety of symptoms may occur but all are of the general "mosaic type."

Control of Raspberry Mosaics

1. *Secure healthy plants for setting*—this is by far the most important control measure.

2. Place the new planting as far as possible from old patches —at least 500 feet.

3. Inspect and rogue new plantings at least twice, preferably three times, the *first year* they are set. The first inspection should be made early in June after new growth has started but before the weather has become hot enough to produce "masking" of symptoms. (Roguing consists of complete removal of infected plants.)

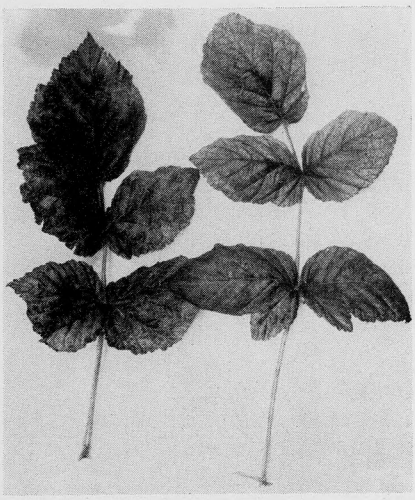

FIG. 4. *Symptoms of yellow mosaic in red raspberry.*

Mosaic symptoms are generally easier to recognize in leaves of the old cane than in the new growth. The first inspection for mosaic, and removal of the "handles" of old cane tips (see Anthracnose control), can be carried out in one operation. It is important to distinguish between true mosaic and symptoms of a harmless trouble of somewhat similar appearance produced by low temperatures. The low temperature injury appears as a yellow or white vein-banding and occurs as a rule on the lower leaves. Injuries produced by red spiders may also resemble symptoms of mosaic. This is particularly true in dry seasons when red spiders are most abundant. On red raspberries, powdery mildew may be easily confused with mosaic but the whitish growth on the under side of the leaf will identify the mildew.

If aphids have appeared before roguing has begun, it will be unsafe to dig the plants without first treating them to kill the insects. If these insects are jarred from the plants in digging, they may fly or crawl to nearby healthy plants and infect them. By far the best procedure is to burn the plant in place with a blow torch or flame thrower. It is only necessary to scorch off all the leaves and to sear the canes. The canes and roots should be removed but this can be done later in the same season. They should never be left until the next season, for the old crowns or roots may produce new shoots. Since the mosaic viruses are present *in the sap of the plant,* the new shoots will always be infected and will again spread infection to healthy plants. Inspection for mosaic and "burning out" of the plants can be done at the same time. In case a flame thrower or torch is not available, the infected plants should be thoroughly sprayed with an

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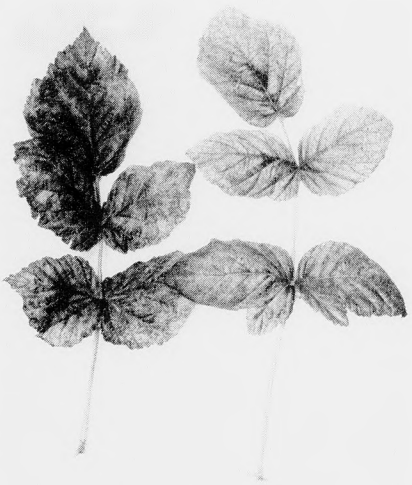

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extra strong solution of a contact insecticide such as nicotine sulfate ("Black Leaf—40") before removal. The plants should then be dug out and burned.

Leaf Curl

There are two forms of leaf curl, one type, alpha curl, attacks only red raspberries, whereas a second type, beta curl, attacks both red and black raspberries. While not prevalent in Maryland at the present time, leaf curl is capable of causing extensive loss. The curl viruses are carried by plant lice in a manner similar to the mosaics.

Symptoms. Plants affected with leaf curl are stunted and the leaves are distorted and curled. Some leaves are much dwarfed and severely distorted, whereas other leaves are nearly normal in size but have a crinkled appearance. Young tips may be distorted when severely infected by curl.

Control. Regular inspection and roguing as described under mosaics will give good control of leaf curl.

Streak Diseases

There probably are several forms of streak (sometimes called "Eastern Blue-stem"), but for practical purposes only two need be considered. These are "severe streak" and "mild streak." So far as is definitely known, only the black raspberry is susceptible to these diseases although the blackberry is under strong suspicion.

SEVERE STREAK

Symptoms of severe streak occur on the leaves of new canes, on the leaves of fruiting laterals, on the surface of new canes (particularly near the ground) and on the fruit itself. *Diseased plants are easily recognized.* The whole plant usually has a yellowish cast and the leaves are curved downward. Yellowing is most pronounced along the veins. The petioles (leaf stalks) are often tinged with red or purple and are inclined so that the whole leaf bends downward. The new canes are heavily marked with blue to purple streaks (Figure 5) which are often slightly sunken. In severe cases, practically the whole cane turns purple through running together of the streaks. Affected canes are stunted and less likely to layer than normal canes. The fruit is generally dull in appearance and shrivels during ripening. Occasionally fairly good fruit will be formed by an infected plant but this is the exception, particularly if the season is at all dry. Infected plants die in from one to several seasons.

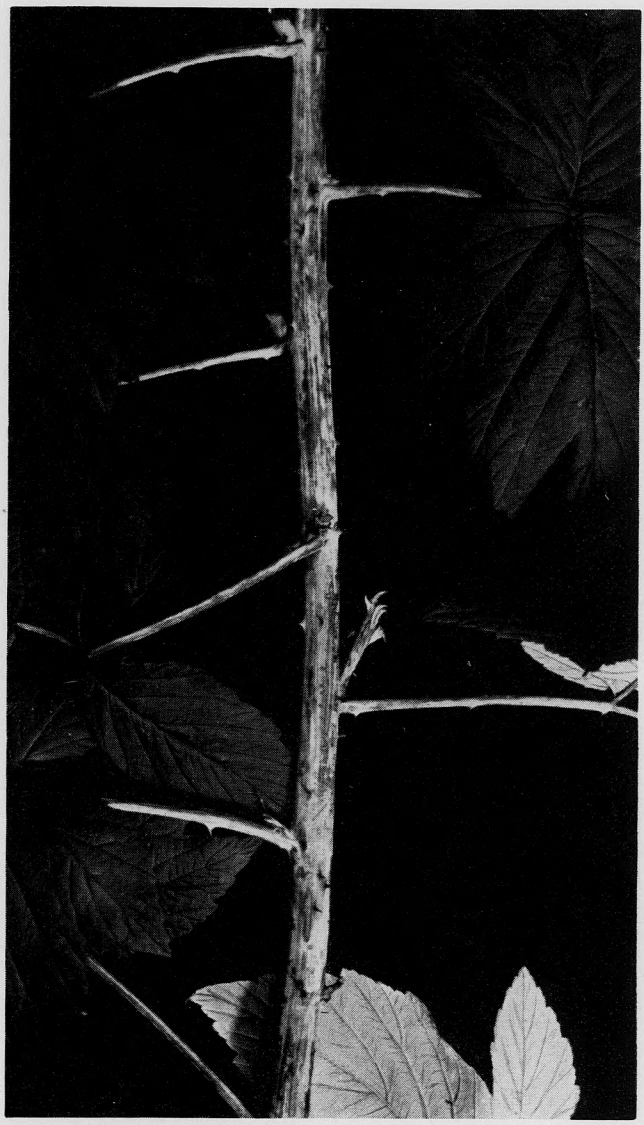

FIG. 5. *Symptoms of severe streak on a new raspberry cane.*

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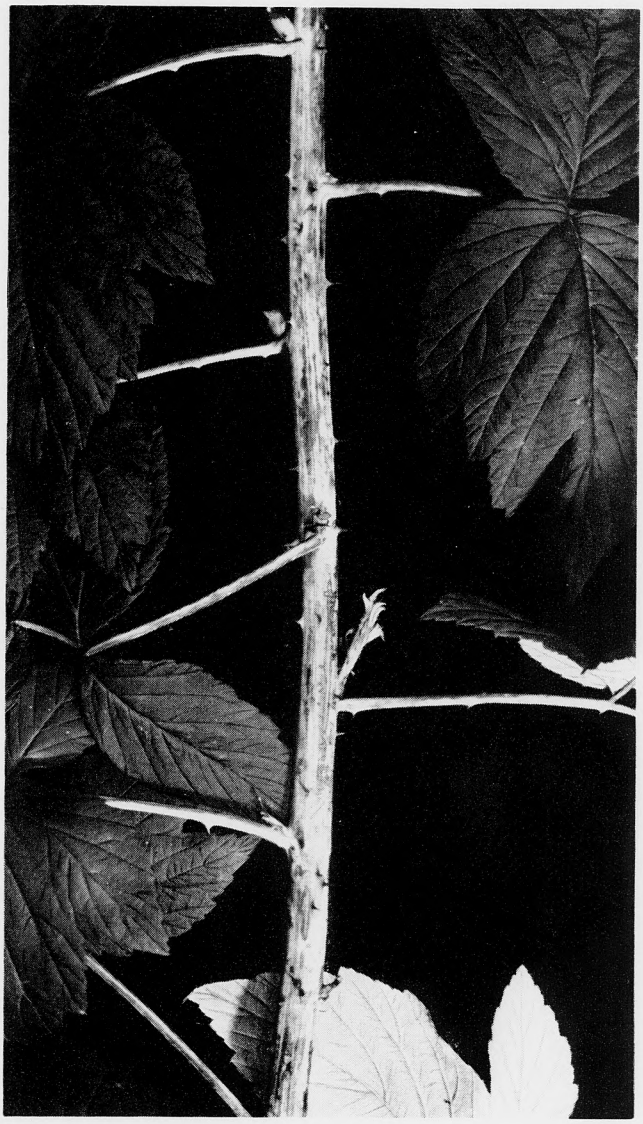

FIG. 5. *Symptoms of severe streak on a new raspberry cane.*

MILD STREAK

Mild streak *is very hard to recognize* and is therefore much more difficult to control than all of the other virus diseases of raspberries. The name is misleading in that effects on the fruit are anything but mild. *While the new canes may be very vigorous, and the fruiting canes themselves appear almost normal, the whole crop of berries frequently dries out during ripening so that it is not salable.* Symptoms may appear on leaves of the new canes, on the surface of the new canes, on leaves of the fruiting canes, and on the fruit. Since control depends on recognition of diseased plants and their prompt removal, the symptoms will be described in detail (see Figure 6 for symptoms on plants in their first growing season).

Symptoms on the New Canes. While there is some variation between varieties, leaves near the tips of the canes frequently roll as shown in Figure 7. There may also be some yellowing or

FIG. 6. *A—General appearance of a healthy raspberry plant.*
B—General appearance of a raspberry plant affected with mild streak. Note the recurved leaves and dull berries.

FIG. 7. *Mild streak-affected tip on left, compared with healthy tip on right.*

clearing along the veins, particularly on leaves near the base of the cane (Figure 8). The leaf stems are often tinged with red or purple and may bend downward so that the leaf is inclined at an abnormal angle (See Figure 6B).

One of the most consistent features of mild streak is the streaking of the new canes (Figures 9 and 10). Unlike severe streak *these markings may be so faint as to be barely detectable.* In some varieties, such as Naples, the streaks are greenish-brown and in others, such as Logan, the streaks are blue-violet to purple. By mid-summer the streaks take on a reddish to purple hue on the "sunny side" of the cane while remaining dull and more or less water-soaked in appearance on the lower or "shaded side". The discolorations on the exposed sides of diseased canes can be distinguished from the normal reddening of healthy canes. On the diseased cane the coloration occurs in streaks, or an irregular pattern formed by merging of the streaks. In the healthy cane a more uniform development of color occurs on the side exposed to the sun.

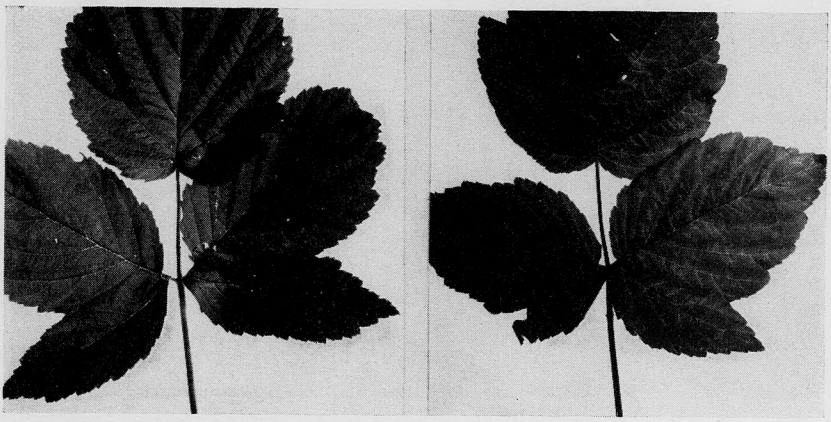

FIG. 8. *Healthy leaf on left, compared with leaf on right from mild streak-affected plant. Note vein clearing in leaf on right.*

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FIG. 8. *Healthy leaf on left, compared with leaf on right from mild streak-affected plant. Note vein clearing in leaf on right.*

Only a few canes in a hill may show streaking, or all of them may be marked. When the bloom is rubbed off, the streaks appear as faintly-colored, water-soaked areas. The discoloration is very shallow and does not extend into the woody tissue. During certain seasons the only visible stem symptoms consist of slight water-soaked lines which are barely visible. Sometimes only one or two streaks appear on a cane but it is not uncommon to find canes so heavily streaked that the whole stem appears dull and water-soaked. The mildest types of stem streaks are not easily recognized without considerable experience, but when leaf and fruit symptoms are considered, identification is much more positive. Sometimes when streaks cannot be detected on the new canes they may be detected in the fruiting laterals.

Symptoms on the Fruiting Canes. The laterals sometimes show streaking of the type found on new canes although this symptom may be absent. In some seasons, however, practically

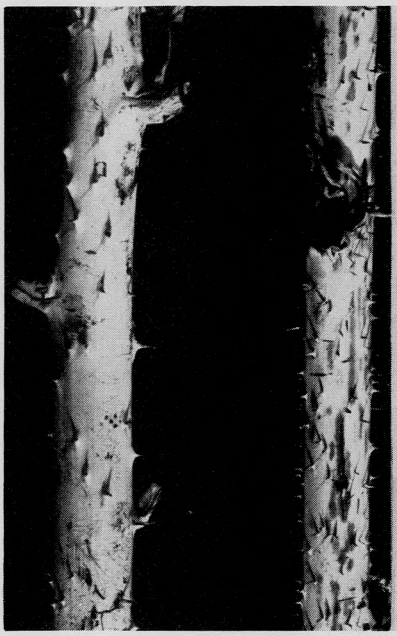


FIG. 9. *Healthy raspberry cane on left, compared with mild streak diseased cane on right.*

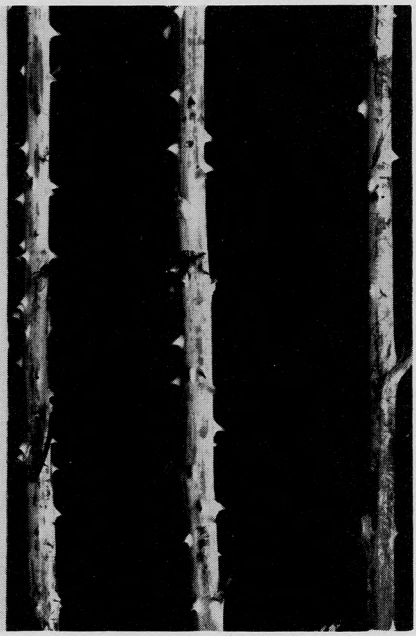


FIG. 10. *The two canes on the left show the faint marking typical of mild streak. The healthy cane on the right has been rubbed.*

all the streaking may appear on the fruiting laterals. Leaf curling and yellowing of the veins though often present do not appear consistently. By far the most pronounced effects are on the fruit (see front cover). The berries are dull in lustre, more or less shriveled, seedy, and of poor flavor. Individual druplets are sunken, thus giving the fruit a pocked appearance. The fruit is often blotched with reddish-purple, as though unevenly ripened. Injury to the berries is more severe when moisture is low during the ripening period. With frequent rains just before harvest, infected plants will produce some fruit which may be harvested. This fact has led growers to the wrong conclusion that infected plants will "recover" from the disease. *Such plants, however, are still diseased and will act as a constant source of infection to the rest of the planting.*

Control of Streak Diseases

1. Inspection and roguing for streak should be done about three times a year. After considerable practice a person can generally recognize streak on the basis of foliage and cane symptoms by mid-summer of the year in which the plants are set. Young plantings should be inspected carefully, for the removal of diseased plants at this time is very important. During the first year of fruiting (second season from setting) mild streak is more readily detected, for it is most easily recognized during the fruit ripening period. It may be inconvenient because of the stress of work at picking time to rogue for streak but unless this is done, mild streak may bring disaster in a few years. Pickers soon learn to recognize the fruit symptoms of mild streak. If they are instructed to mark diseased plants with a tag of cloth at the time of picking, another person could follow with a blow torch or flame thrower to destroy the marked plants. This would have to be done only the first one or two fruiting seasons and since the profitable life of the planting may thereby be prolonged several years the time and expense is fully justified. If the destroyed plants are replaced, only healthy re-plants should be used.

2. It has been observed repeatedly that streak in raspberries is more prevalent when blackberries are grown nearby. The blackberries may carry the virus or encourage multiplication of the insect that carries the streak virus. For this reason black raspberries should be grown as far away from blackberries as possible.

3. In general, roguing for streak and mosaic can be carried on simultaneously.

Only a few canes in a hill may show streaking, or all of them may be marked. When the bloom is rubbed off, the streaks appear as faintly-colored, water-soaked areas. The discoloration is very shallow and does not extend into the woody tissue. During certain seasons the only visible stem symptoms consist of slight water-soaked lines which are barely visible. Sometimes only one or two streaks appear on a cane but it is not uncommon to find canes so heavily streaked that the whole stem appears dull and water-soaked. The mildest types of stem streaks are not easily recognized without considerable experience, but when leaf and fruit symptoms are considered, identification is much more positive. Sometimes when streaks cannot be detected on the new canes they may be detected in the fruiting laterals.

Symptoms on the Fruiting Canes. The laterals sometimes show streaking of the type found on new canes although this symptom may be absent. In some seasons, however, practically

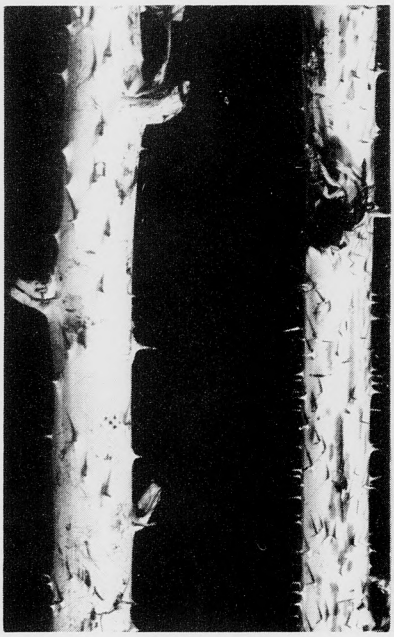
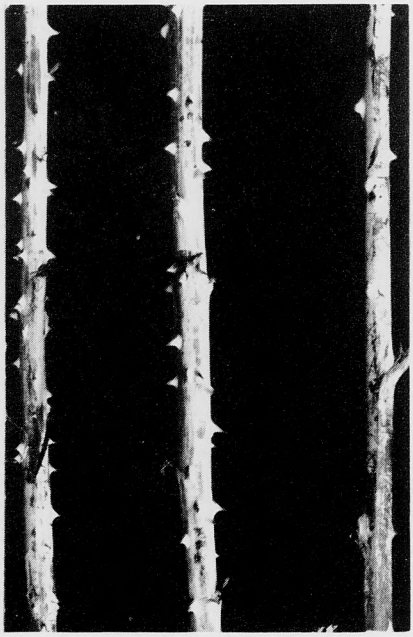


FIG. 9. *Healthy raspberry cane on left, compared with mild streak diseased cane on right.*



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3. In general, roguing for streak and mosaic can be carried on simultaneously.

FIG. 11. *A—Young cane in the first stages of verticillium wilt.*

B—A wilt-affected cane on the right, a diseased cane that has been split to show interior darkening, and a healthy cane that has been split for comparison.

FUNGUS DISEASES[1]

Whereas the virus diseases of raspberries are caused by invisible agents (viruses), the fungus diseases are caused by organisms which are visible through the microscope.

Fungus diseases are greatly affected by weather conditions, thus certain of these diseases are severe in wet seasons while others are more serious during dry seasons. This is the basis for the common belief that many of the diseases of raspberries are due directly to the weather but if the trouble is studied carefully it will usually be found that the weather has merely been favorable for the development of the parasite.

These fungus troubles are caused by small, parasitic plants which multiply by very small, seed-like bodies known as spores. The spores germinate and grow, just as do the seeds of higher plants, and bring about new infections. These parasitic fungi over-winter in the old canes, in the new canes and, in some cases, in the soil. Wild brambles also harbor infection.

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[1]For summarized control procedures covering all the raspberry diseases, see section entitled *General Control Practices.*

Fungus Diseases Not Controlled By Spraying

WILT OR BLUE STEM[1]

Wilt or blue stem of raspberry is caused by a soil-inhabiting fungus that also causes wilt in such crops as tomato, potato, pepper, and eggplant. Both red and black raspberries are susceptible, but usually the effects are not as severe on the red varieties grown in Maryland as on the blacks.

Symptoms. The first noticeable effects of the disease usually appear shortly before harvest time. Leaves of black raspberries become pale and the cane tips grow slowly and bend downwards; soon the lower leaves wilt and dry up (Figure 11). Later more of the foliage may die (Figure 12). Canes wilt and turn a dark blue color and finally the whole plant dies. When canes are cut, the water-conducting tissue is seen to be darkened (Figure 11B). Death of the plant often does not occur until the season following the first noticeable infection.

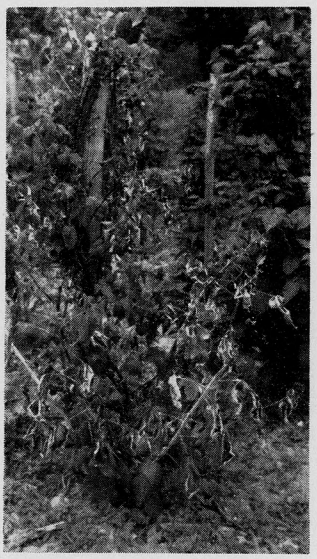

FIG. 12. *Black raspberry plant in a late stage of verticillium wilt.*

On red raspberries, the symptoms are very similar but new shoots are usually formed which prevent the severe effects found in black caps. In both reds and blacks whole hills may be affected or only one or two canes per hill may show the symptoms. Even if canes are not killed by the wilt fungus they may be so affected that the fruit will dry up. Roots may be rotted extensively and show reddish-brown discolorations which are also found in the canes.

The wilt parasite can live for several years in soil organic matter or in some other crop, such as potatoes or tomatoes. Plants set in wilt "sick" soil of good fertility do not succumb as rapidly as plants set in wilt infested soil that is not very fertile.

Certain types of wilt and root-rot have been observed in Maryland which appear to be different from the wilt described above. The symptoms are similar but the soil relations, effect on other crops, etc., may not be the same. More research on these troubles is needed before final conclusions can be drawn.

[1]Caused by *Verticillium alboatrum* Reinke and Berth.

FIG. 11. *A—Young cane in the first stages of verticillium wilt.*

B—A wilt-affected cane on the right, a diseased cane that has been split to show interior darkening, and a healthy cane that has been split for comparison.

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Control:

1. Avoid poorly drained soil or areas subject to washing from surface water.
2. Do not set raspberry plants immediately following potatoes or tomatoes, particularly if these crops have shown symptoms of wilt, and do not inter-plant with these crops.
3. Do not set plants from wilt diseased plantings.
4. Maintain proper soil fertility.
5. Avoid transfer of soil (on cultivating tools, etc.) from infected areas to healthy fields.

ORANGE RUST[1]

Rust or "yellows" is caused by a fungus which invades the tissues of raspberry and blackberry plants and produces an orange-colored powder of spores on the under side of the leaves. This is one fungus disease that is systemic, the causal organism being found throughout the whole plant, whereas in the case of most fungus diseases the organism is found only in certain parts of the plant. Diseased plants are stunted and may produce many new canes which are spindly and usually devoid of spines. In some cases only a portion of the plant may be affected. Leaves are misshapen and after unfolding the lower surface becomes covered with orange-colored spores.

The mycelium (vegetative body) of the fungus lives throughout the year between the cells of the stem, crown, and roots of affected plants. Each season, as new growth begins, the fungus makes additional growth and invades the new tissues. *Infected plants never recover.*

Control.

1. Destroy surrounding wild brambles.
2. Pull out infected plants by the roots and burn before the dust-like rusty spores are shed.
3. If infected plants are shedding spores, all of the leaves should be burned with a torch or sprayed with a strong solution of nitrate of soda (1 lb. in 5 gal.) before removal of the plants. This procedure prevents scattering of the spores. Sprayed plants should not be removed until the foliage is dead.

NON-SYSTEMIC LEAF RUSTS

Raspberries are occasionally attacked by other types of rust. One of these produces yellow spores on infected leaves and another produces orange-colored spores. The spore masses are not as conspicuous as in orange rust and occur only on the leaves

[1]Caused by *Gymnoconia interstitialis* (Schl.) Lagh.

without affecting the canes. These non-systemic leaf rusts do little damage and plants affected with them, unlike those affected with orange rust, will recover.

No special control practices are necessary.

Fungus Diseases Controlled By Spraying

ANTHRACNOSE[1]

Anthracnose is one of the worst raspberry diseases in Maryland, for it is common in most of the plantings and causes much loss every year. This disease can occur on all of the varieties usually grown, although black caps are more severely injured than red raspberries. Anthracnose is also common on purple raspberries and on blackberries. Certain varieties of black-caps are more resistant than others. The chief loss from anthracnose results from a continuous weakening of the plant which in a short time leads to very poor production and finally to death.

On the young shoots anthracnose appears as circular, reddish-brown, sunken spots. Mature spots (Figure 13A) are more or less circular with a purple margin and a light grey center, and may reach a size of $\frac{3}{8}$ inch in diameter. The lesions often become so numerous that large areas of a canker-like nature result. These cankers sometimes split, thus causing further injury.

[1]Caused by *Plectodiscella veneta* (Speg.) Burk.

FIG. 13. *A—Anthracnose on stem of a black raspberry plant.*
B—Same disease on the leaf.

Control:

1. Avoid poorly drained soil or areas subject to washing from surface water.
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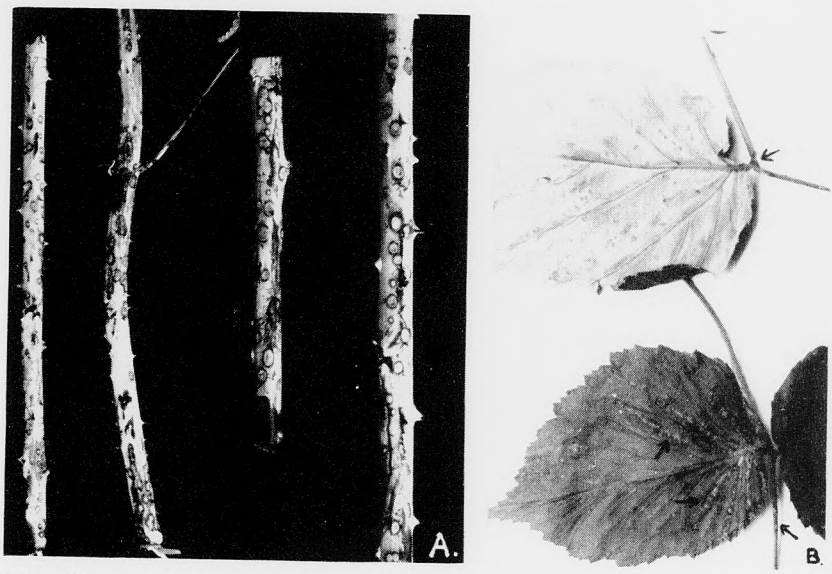

FIG. 13. *A—Anthracnose on stem of a black raspberry plant.*
B—Same disease on the leaf.

Anthracnose appears on the leaves (Figure 13B), in the spring, as small yellowish spots. Later these spots enlarge to about 1/8 inch, with light centers and red margins. Such spots sometimes develop shot-holes. On fruit, leaf, and flower stalks, the spots are sunken and greenish-brown but may not have the purple margins. White scab-like patches resulting from union of several spots occasionally result.

Attacks of the anthracnose fungus on the fruit cause parts of fruits to fail to mature. In severe cases the entire fruit may dry up, due to loss of water from infected canes.

Control.

1. Removal of "handles" from black raspberry sets as soon after planting as possible (See note on mosaic control).
2. Removal and destruction of heavily infected new canes.
3. Prompt removal and destruction of fruiting canes after harvest.
4. Control of weeds to allow free air circulation.
5. Spraying as outlined in *General Control Practices.*

CANE BLIGHT[1]

Cane blight is a fungus disease which is found in all of the main raspberry sections of the United States. In Maryland, it is often severe on both red and black varieties.

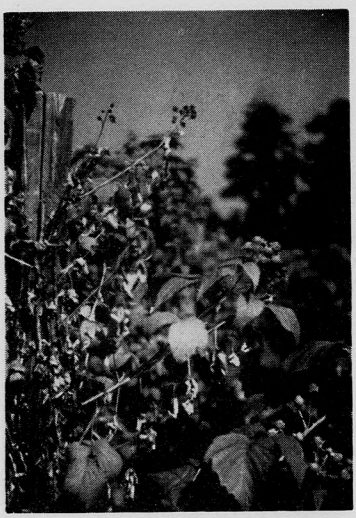

FIG. 14. *Cane blight of black raspberry. Note dead canes next to post.*

There probably is a close connection between cane blight and winter injury for it often appears that canes which have suffered from cold injury are also attacked by cane blight. The effect of cane blight is usually noticed between blossom period and fruiting time. The affected canes begin to wilt, the leaves droop and turn brown, the berries dry up and the canes become brittle (Figure 14). As a rule, the whole plant is not killed but individual canes or parts of canes are killed. Discolored areas caused by direct invasion of the fungus are often found on the diseased canes. Parts of the cane above such areas die, so that the amount of killing is dependent upon the number and position of these cankered areas.

[1]Caused by *Leptosphaeria coniothyrium* (Fcl.) Sacc.

The main source of infection by cane blight is through wounded areas; even small insect punctures will afford entrance to the fungus.

Control.

1. Avoid planting sites with poor air and soil drainage.
2. Remove and destroy fruiting canes as soon as possible after harvest; and remove and burn blighted parts during growing season.
3. Maintain adequate soil fertility.
4. Control weeds.
5. Spray according to schedule in *General Control Practices.*

SPUR BLIGHT[1]

Spur blight is another fungus disease which causes serious losses to raspberry growers in Maryland. The disease is so named because of its habit of attacking the spurs of the canes and causing death or serious injury to them. Usually spur blight is more destructive to red raspberries than blacks but nearly all varieties may be affected.

The first definite symptoms of this disease consist of dark, reddish-brown areas on the canes at the point of attachment of the leaves. These discolored areas enlarge and usually surround the leaf base and bud. Sometimes these areas may be so numerous as to darken the whole lower part of the cane. The infected area gradually turns brown and finally grey. Numerous black, pimple-like, spore-producing bodies develop in the grey bark. If the buds are not killed during the summer they are so weakened that in the fruiting season they produce only sickly laterals which usually die before they mature fruit. Losses from spur blight, in individual plantings, may reach 75% of the crop.

Control.

1. Avoid planting sites with poor air and soil drainage.
2. Remove and destroy fruiting canes as soon after harvest as possible and remove and burn blighted parts during growing season.
3. Maintain adequate soil fertility.
4. Control weeds.
5. Spray according to schedule in *General Control Practices.*

POWDERY MILDEW[2]

Most commercial varieties of red and black raspberries are quite resistant to powdery mildew. Under certain environmental conditions, poor air drainage for example, mildew may do exten-

[1]Caused by *Didymella applanata* (Niessl.) Sacc.
[2]Caused by *Sphaerotheca humuli* (D. C.) Wint.

Anthracnose appears on the leaves (Figure 13B), in the spring, as small yellowish spots. Later these spots enlarge to about 1/8 inch, with light centers and red margins. Such spots sometimes develop shot-holes. On fruit, leaf, and flower stalks, the spots are sunken and greenish-brown but may not have the purple margins. White scab-like patches resulting from union of several spots occasionally result.

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sive damage. The red variety Latham is usually not severely injured by mildew in Maryland. However, in a few locations, especially where poor air-drainage existed, this variety has been found so heavily mildewed as to be unprofitable. Control may not be practicable on very susceptible varieties under such conditions.

FIG. 15. *Effect of powdery mildew on raspberry. Note cupping of upper leaves.*

Symptoms. The fungus attacks leaves and tender young stems. In mild attacks a few large, light-green to yellow blotches appear on the upper surface of older leaves and may be confused with the symptoms of mosaic. On the under surface of the leaf, opposite the blotches, a silvery white growth of mildew may develop. Young leaflets and the cane tip are sometimes distorted and curled. The leaves often appear yellowish and water-soaked, the mildew being present in varying amounts. The white mildew is best seen on the under surface of the leaves. Very severe cases of mildew result in copious development (Figure 15) of silvery white mold on the surface of affected parts and severe stunting or death of the new cane growth and leaves.

Control.

1. The regular spray program as outlined under *General Control* will ordinarily check development of powdery mildew.

2. Maintenance of proper air drainage is the most important factor in control. In some locations, where air drainage is poor, it may not be possible to control powdery mildew on very susceptible varieties, even by spraying. In such cases mildew-resistant varieties may be used.

LEAF SPOT[1]

Leaf spot, which attacks both black and red raspberries, is ordinarily not widespread until late in the season. Severe

[1]Caused by *Mycosphaerella rubi* E. W. Roark.

FIG. 16. *Leaf spot on black raspberry.*

attacks may devitalize the canes so that they are more subject to winter kill.

Symptoms. Dark reddish spots appear on the leaves in the spring. The spots are round and about one-eighth inch in diameter. Gradually the spots turn brown to whitish brown in color (Figure 16) and sometimes remain surrounded by a reddish border. Small pimple-like, spore-producing bodies develop in the spots and serve to spread the infection. Spots may be so numerous as to run together, killing practically the whole leaf. Direct infection of the canes, when it occurs, is very slight.

Control. The regular spray schedule will ordinarily give satisfactory control.

BACTERIAL DISEASES

The only bacterial disease which is of any importance on raspberries is crown gall.

CROWN GALL[1]

Crown gall is caused by minute soil-borne bacteria. Both red and black varieties may be affected, although the disease is especially disastrous to red raspberries. Blackberries are also very susceptible to infection.

Symptoms. Irregular, wart-like swellings develop on the crown (Figure 17) or along the canes. The galls may be wholly below ground or several feet up on the cane. Plants infected two or three years after setting may not be greatly stunted. However, if the sets are infected

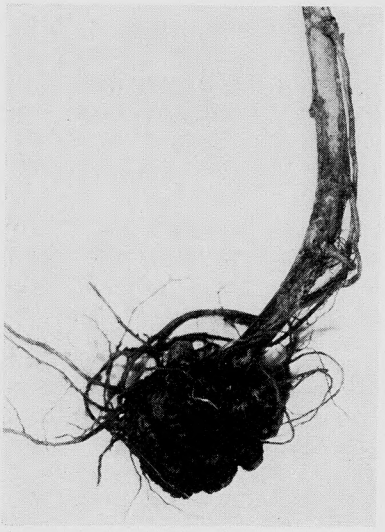

FIG. 17. *Crown gall on black raspberry.*

[1]Caused by *Phytomonas tumefaciens* (Sm. and Town.)

sive damage. The red variety Latham is usually not severely injured by mildew in Maryland. However, in a few locations, especially where poor air-drainage existed, this variety has been found so heavily mildewed as to be unprofitable. Control may not be practicable on very susceptible varieties under such conditions.

FIG. 15. *Effect of powdery mildew on raspberry. Note cupping of upper leaves.*

Symptoms. The fungus attacks leaves and tender young stems. In mild attacks a few large, light-green to yellow blotches appear on the upper surface of older leaves and may be confused with the symptoms of mosaic. On the under surface of the leaf, opposite the blotches, a silvery white growth of mildew may develop. Young leaflets and the cane tip are sometimes distorted and curled. The leaves often appear yellowish and water-soaked, the mildew being present in varying amounts. The white mildew is best seen on the under surface of the leaves. Very severe cases of mildew result in copious development (Figure 15) of silvery white mold on the surface of affected parts and severe stunting or death of the new cane growth and leaves.

Control.

1. The regular spray program as outlined under *General Control* will ordinarily check development of powdery mildew.

2. Maintenance of proper air drainage is the most important factor in control. In some locations, where air drainage is poor, it may not be possible to control powdery mildew on very susceptible varieties, even by spraying. In such cases mildew-resistant varieties may be used.

LEAF SPOT[1]

Leaf spot, which attacks both black and red raspberries, is ordinarily not widespread until late in the season. Severe

[1]Caused by *Mycosphaerella rubi* E. W. Roark.

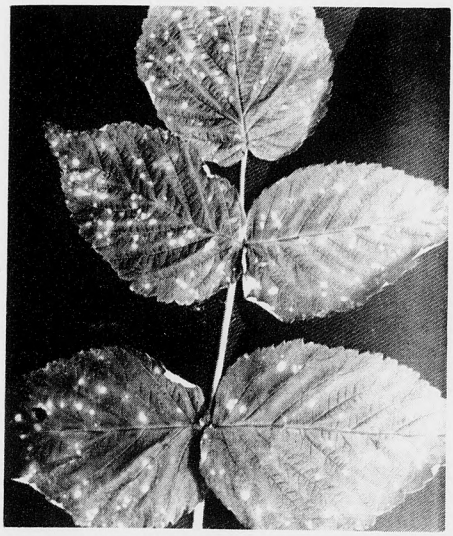

FIG. 16. *Leaf spot on black raspberry.*

attacks may devitalize the canes so that they are more subject to winter kill.

Symptoms. Dark reddish spots appear on the leaves in the spring. The spots are round and about one-eighth inch in diameter. Gradually the spots turn brown to whitish brown in color (Figure 16) and sometimes remain surrounded by a reddish border. Small pimple-like, spore-producing bodies develop in the spots and serve to spread the infection. Spots may be so numerous as to run together, killing practically the whole leaf. Direct infection of the canes, when it occurs, is very slight.

Control. The regular spray schedule will ordinarily give satisfactory control.

BACTERIAL DISEASES

The only bacterial disease which is of any importance on raspberries is crown gall.

CROWN GALL[1]

Crown gall is caused by minute soil-borne bacteria. Both red and black varieties may be affected, although the disease is especially disastrous to red raspberries. Blackberries are also very susceptible to infection.

FIG. 17. *Crown gall on black raspberry.*

Symptoms. Irregular, wart-like swellings develop on the crown (Figure 17) or along the canes. The galls may be wholly below ground or several feet up on the cane. Plants infected two or three years after setting may not be greatly stunted. However, if the sets are infected

[1]Caused by *Phytomonas tumefaciens* (Sm. and Town.)

before or shortly after planting, extreme stunting or complete failure of growth often results.

Control. Plant disease-free sets in clean ground. If an old planting shows any crown gall, a new planting should not be made in the same soil for several years following removal of the old plants.

NON-PARASITIC DISEASES

WINTER INJURY

Varieties of raspberries differ greatly in their susceptibility to winter injury. Such injury usually consists of a killing-back of the canes from the tip. The cane may be killed to the ground, but in spite of this some of the basal buds will form fruiting laterals the following spring.

Red varieties, like Marcy, Newburgh and Taylor, while very desirable from other standpoints, are subject to winter kill in parts of Western Maryland. Taylor and Newburgh may come through the winter with only partial injury, or in some years with no injury when grown on lighter soils. Marcy is very subject to winter kill under Maryland conditions. The most widely grown varieties in Maryland, Latham (red) and Cumberland (black) are relatively tolerant to winter injury, especially when free from disease.

Control.

1. Select varieties adapted to the region where they are to be grown.
2. Select well-drained soil.
3. Use proper cultural practices to avoid rapid growth late in the summer, when the new canes should be ripening off. Applications of nitrogen or heavy applications of chicken manure should not be applied after growth has begun in the spring and during the growing season.
4. When susceptible varieties are grown, canes should not be thinned heavily in the spring until after growth commences and the extent of winter injury can be seen.

INJURIES FROM IMPROPER DRAINAGE

Most of the Maryland raspberry section is well drained but there are small sites in which water becomes pocketed and is not carried off readily. Raspberry plants are sensitive to "wet feet" and therefore should not be planted where the soil is apt to remain very wet for several days. If the soil is too wet in the spring, the leaves will turn yellow and the whole plant will be weakened. An excess of water in the fall will prevent proper maturing of new canes and winter injury will result.

GENERAL CONTROL PRACTICES

Successful control of raspberry diseases in Maryland cannot be based on any single procedure. Spraying, for example, will aid greatly in control of certain fungus diseases such as anthracnose, spur-blight, cane-blight, powdery mildew, and leaf spot. But mosaic, streak, wilt, orange rust, leaf curl, and crown gall cannot be controlled by any spray practice. It is important, therefore, to know something of the nature of each disease and the control measures that specifically apply. (See preceding disease descriptions.)

The following general practices are of great importance:

1. New plantings should be made with sets definitely known to be free from disease and should be inspected at least three times the first year and three times the second year. Inspections are best made at fruiting time (for mild streak) and in early fall. Diseased plants should be removed as described under virus diseases.

Roguing beyond the second season of growth is not always practicable. *Roguing for mild streak when picking operations are underway is very inconvenient but unfortunately very necessary if the grower wishes to guard against disaster in the future.* (See further details under *Streak Diseases*).

2. New plantings should be isolated as far as possible from all sources of infection. Old plantings, diseased young plantings, wild brambles and cultivated blackberries should be regarded as potential sources of infection.

3. Whether planting on the row or hill system the field lay-out should be made with regard to future spraying operations. With the hedge-row system, a spacing of at least 6 feet between rows is desirable. Sufficient room should be left at the ends for turning in case a horse-drawn sprayer is to be used.

4. The old canes or "handles" should be removed as soon as practicable from black raspberry sets, as they often carry anthracnose. Some growers prefer to leave them as cultivation markers until new growth has started. The leaves that form on these "handles" are also an aid in detecting early symptoms of mosaic and streak, in which case they may be left on until the first roguing for these virus diseases has been completed. If, however, the "handles" are infected with anthracnose, they should be removed before the new canes appear.

5. Old fruiting canes should be removed (cut as close to the ground as possible) soon after harvest. All such material should be piled and burned, since several of the raspberry parasites multiply in the dead wood and bark.

6. Control of weeds aids in control of anthracnose, spur-blight, and certain other fungus diseases by providing good air circulation about the canes.

7. Wild brambles harbor viruses and parasitic fungi, thus constituting a menace to cultivated raspberries. Removal or destruction of these wild plants as far as practicable will aid in control of these diseases.

Spray Program

It has been pointed out that spraying *will not* control some of the most troublesome raspberry diseases. On the other hand, spraying will aid materially in controlling anthracnose, spur-blight, leaf-spot, and powdery mildew. Cane-blight is checked to some extent by spraying but not as greatly as are those diseases just mentioned. Under certain conditions powdery mildew may be too prevalent for control by fungicides. Whether spraying will be beneficial depends upon the particular disease or diseases which are present. Plantings heavily infested require more frequent applications of spray material than lightly infested plantings. It is sometimes possible to start with an intensive spray program and after one or more years to shift to a program based on only one or two spray applications each season. If a grower starts with clean stock in a well isolated or relatively disease-free area, he may obtain satisfactory control of anthracnose, spur-blight, etc., with only the *delayed dormant* application of lime-sulfur 1-12. Thorough, timely applications with the right materials are a requisite of successful spraying.

The spray program on page 23 has been developed jointly by the departments of Horticulture, Plant Pathology and Entomology. *Raspberry foliage is easily injured by excessive concentrations of spray materials, therefore, only the recommended amounts should be used.*

RASPBERRY INSECT AND DISEASE SPRAY CALENDAR

Time to Apply	Pests To Be Controlled	Material to Use	Remarks
1. **Delayed Dormant** At time buds begin to break and show silver and before leaves are ⅛ inch long.	Anthracnose Cane Blight Spur Blight (on reds) Scale Insects	Concentrated liquid lime-sulfur, 4 gals. and water to make 50 gals. (about 1 to 12). If scale is serious, use 6 gals. lime-sulphur instead of 4 gals.	*Spray thoroughly* so as to cover all parts of the canes. See Note 1.
2. **Pre-Blossom** About one week before blooming.	Anthracnose Cane Blight Spur Blight (on reds) Raspberry Beetle Tree Cricket	Bordeaux Mixture, 2-4-50. Add 1½ lbs. of lead arsenate to each 50 gals. of Bordeaux Mixture, if these insects are serious.	Make sure that the new canes are covered by the spray. See Note 2 for making Bordeaux Mixture.
3. **After Blossom** As soon as blossoming is over.	Anthracnose Cane Blight Spur Blight (on reds) Red Spider	Bordeaux Mixture, 2-4-50. If red spider is present, use conc. lime-sulfur, 1 gal. per 50 gals. water instead of Bordeaux Mixture.	Cover the new canes with the spray. If a spreader or sticker is needed, see Note 3.
4. No Spray	Raspberry Cane-Borer	Watch for girdled tips on the plants. Cut the cane off below girdled tip, burn	Cut and burn all old canes after harvest, if possible, and all dead canes in the fall, if this insect is serious.
5. No Spray	Raspberry Cane-Borer	Watch for wilting of canes. Cut cane close to crown and burn.	
6. **After Harvest** As soon after as possible.	Anthracnose Cane Blight Spur Blight (on reds)	Bordeaux Mixture, 2-4-50.	SPRAY THOROUGHLY. See Note 4.

NOTE 1. The first two sprays are especially important. The later sprays should be applied, if individual conditions warrant.

NOTE 2. Bordeaux Mixture 2-4-50 is a mixture of 2 lbs. of copper sulfate (blue vitriol), 4 lbs. of high calcium hydrated lime, and 50 gallons of water. In a wooden bucket, stone crock or enamel bucket dissolve 2 lbs. of copper sulfate in water. Use the powdered copper sulfate, as it dissolves faster. Pour this material into the spray tank, and fill the tank over half full with water. Then make the lime (4 lbs.) into a thin, milky paste, using as much water as necessary, and pour it into the tank, filling the tank to the top with water, and the material is ready to use. *Do not* pour the strong solutions of lime and copper sulfate directly together, as they will jell and be worthless. Always add plenty of water to one or the other before mixing them together. Agitate mixture while spraying.

Stock Solutions. Another method very convenient when large amounts are needed is the use of stock solutions. Stock solutions of copper sulfate and of lime may be made by dissolving the materials in water, in separate containers, at the rate of 1 lb. of the materials in each 1 gal. of water. Then, to make up a tank of mixture, merely add 2 gals. of the copper sulfate solution to the spray tank and fill one-half full of water, stir in 4 gals. of the lime solution, fill the tank to the top, and the spray is ready for use.

NOTE 3. Bordeaux Mixture has good sticking qualities, but if it is found that the spray is not sticking to the new canes, common flour stirred into a thin paste (1 lb. flour to 50 gals. of spray) or skimmilk (1 gal. to 50 gals. of spray) will help the spray to stick a little better.

NOTE 4. The after-harvest spray is important, but difficult to apply, as the canes are rank in growth and it is hard to get into the patch. It would be well if the old canes could be removed immediately after harvest, the new canes tied up, and weak canes cut out. If pressure of work is such that this cannot be done, the spray should be applied anyway, if disease is showing on the new canes. If removing old canes cannot be done soon after harvest, spray first and remove afterwards.

Healthy Planting Stocks

Healthy planting stocks are absolutely essential for development of a vigorous, long-lived raspberry plantation. All other control measures are likely to fail unless the grower starts right with clean plants. The production of disease-free raspberry planting stock is a highly specialized business. Ordinary methods of nursery certification are often not adequate to insure reasonably disease-free stock. Plants should never be taken from plantings that have not been carefully inspected at least three times the previous growing season by a person able to recognize the various diseases. Mild Streak and Crown Gall are often present in stock that is free from other diseases and such plantings look very vigorous. Vigor alone is a very unreliable index. The University of Maryland Extension Service will assist growers in locating sources of desirable planting stock and in giving special advice as to its maintenance, since particular situations may require procedures not covered in this bulletin.

ACKNOWLEDGEMENTS

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The following photographs are by Mrs. H. L. Stier: Front cover, Figures 1, 2-A, 4, 5, 7, 8, 9, 17.

Cultural practices in this bulletin, as they pertain to disease control, have been approved by the Horticulture Department of the University of Maryland.

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